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ABSTRACT

This manual is intended to aid the instructor in using the competency-based electronics technician curriculum developed for use in electronics courses in Kentucky. The first section of the manual provides a master sequence of program components, with tasks matched to textbook units and laboratory manual sections. The second and third sections of the guide provide information on instructional materials and equipment needed, while the fourth section suggests ways to modify the curriculum to meet the needs of special students. The main section is the instructor's guide to learning activities for the 15 tasks of the curriculum. Each guide sheet contains objectives, attitudes and values to be developed, contents of the learning activities, checkout activities, and suggested references. The student task assignment sheets are also included. (KC)

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Instructor's Manual

ELECTRONICS TECHNICIAN

Competency - Based Education

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1984
Kentucky Department of Education
Alice McDonald, Superintendent of Public Instruction

A Competancy Based Curriculum in the Area of

ELECTRONICS TECHNICIAN

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[Student Task Assignment Sheets]

INTRODUCTION

The Electronics program was chosen as a curriculum project to continue the commitment toward competency based instruction for all programs in Kentucky's Vocational Schools.

The tasks were identified and validated by a committee consisting of representatives from industries throughout the State of Kentucky. These industries are involved in manufacturing electronics equipment, use of electronics equipment in manufacturing processes and repair of electronics equipment. The tasks that are used in the core curriculum, called Electronics Technician, were chosen by the committee as representing the minimal performance level expected of anyone who would be hired as an Electronics Technician.

The reference material was chosen by Electronics teachers during a summer workshop. The reference material supports the entire core curriculum for Electronics. The teachers believe that all of the tasks are covered by this material to some degree. Teachers are encouraged to supplement this reference material with other material which they are now using or will identify in the future. It is believed that most teachers are familiar with and are already using some Heathkit/Zenith material. Another reason for choosing this reference material is the accompanying University of Missouri material which enhances it with additional worksheets and teacher guides. You will find that all of this has been keyed together by the "Program Master Sequence" in this manual.

There are many excellent Electronics programs in Kentucky, and we believe this curriculum will assist those programs in meeting the needs of industry.

MATERIAL WRITERS AND REVISERS

Charles Cave teaches Electronics at Ahrens Area Vocational Education Center in Louisville, Kentucky. Mr. Cave has 22 years work experience in industry and over 25 years teaching experience. He has 45 hours earned toward a B.S. degree and has attended innumerable workshops and classes in the field of Electronics. This is the second curriculum development project that Mr. Cave has participated in.

Michael Dixon teaches Electronics at Somerset State Vocational-Technical School in Somerset, Kentucky. Mr. Dixon has five years experience in industry as an Electronics Technician and six years teaching experience. He has an M.S. and Rank I in both Secondary Education and Vocational Education, has an A.S. in Electrical Engineering, and is completing requirements for an Ed. D. at University of Kentucky. Mr. Dixon is a Certified Electronic Technician (C.E.T.).

Fred Hines teaches Electronics at Northern Kentucky State Vocational-Technical School in Covington, Kentucky. Mr. Hines has 11 years work experience in industry as an Electronics Technician and 16 years teaching experience. He is just a few hours short of earning a B.S. degree, has completed numerous courses in math and electronics, including Communications Engineering, Television Engineering and many Air Force technical schools in Electronics. Mr. Hines is a prolific writer, having written for industry, education and magazines, including "School Shop Magazine" and "Popular Electronics."

Harry Miller teaches at Ashland State Vocational-Technical School in Ashland, Kentucky. Mr. Miller has over 20 years work experience in Electronics. He has taught Electronics in the Navy, in private schools, and has 10 years teaching experience at Ashland State Vo-Tech. Mr. Miller has an A.A.S. degree and has completed many workshops and classes in Electronics.

John Ward teaches at Central Kentucky State Vocational-Technical School in Lexington, Kentucky. Mr. Ward has 12 years work experience in industry and 10 years teaching experience in both Electricity and Electronics. He has a B.S. in Industrial Education and is working toward an M.S. Mr. Ward is a graduate of both Industrial Electricity and Electronics programs at vocational schools.

ACKNOWLEDGEMENTS

In addition to those teachers who wrote and revised the task assignment sheets, there were contributions from many others.

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D.C. CIRCUITS

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Safety (To Be Covered Before Teaching Any Tasks)	0	None	DC2-4
Relate electricity to nature of matter.	1	None	None
Identify sources of electricity.	2	None	None
Set up and operate power supplies for DC circuits.	2	1, 2, 3	DC3-2 DC3-3
Read and interpret color codes to identify resistors.	3	4	DC3-5
Compute and measure conductance and resistance of conductors and insulators.	3	5, 6	DC3-4
Solve basic algebra problems.	4	8, 9, 10	DC3-5 DC3-1
Define voltage, current, resistance, power, and energy.	4	8, 10	None
Apply and relate Ohms Law.	4	9	DC4-1
Analyze basic motor theory and operation.	5	None	None
Analyze basic generator theory and operation.	5	None	None
Define magnetic properties of circuits and devices.	5, 8	11, 12	DC5-3
Measure properties of a circuit using VOM and DVM meters.	6	13, 14	DC6-2
Analyze series circuits.	7	None	DC4-2 DC3-4 DC2-2
Construct series circuits.	7	None	DC2-2
Troubleshoot series circuits.	7	None	DC2-2
Analyze parallel circuits.	7	None	DC2-3
Construct parallel circuits.	7	None	DC2-3
Troubleshoot parallel circuits.	7	None	DC2-3

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Analyze series-parallel circuits.	7	None	DC4-3 DC2-3
Construct series-parallel circuits.	7	None	DC2-3
Troubleshoot series-parallel circuits.	7	None	DC2-3
Analyze voltage dividers (loaded and unloaded).	7	None	None
Construct voltage dividers (loaded and unloaded).	7	None	None
Troubleshoot voltage dividers (loaded and unloaded).	7	None	None
Use Kirchoff and Thevenin's theories to solve network problems.	7	15, 16	None
Analyze maximum power transfer theory.	7	17	DC7-4
Construct circuits to demonstrate maximum power transfer theory.	7	17	DC7-4
Troubleshoot maximum power transfer circuits.	7	17	DC7-4
Determine physical and electrical characteristics of capacitors and inductors.	8	18, 19, 20	DC8-3
Analyze and measure RL and RC time constants.	8	18, 19, 20	DC8-2

A.C. CIRCUITS

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Identify properties of an AC signal.	1	None	None
Identify AC sources.	1	None	None
Confirm peak, rms, and average relationships.	1	1	AC2-2
Identify the operating controls of an oscilloscope.	2	None	AC2-1
Adjust the scope controls properly to observe an A.C. voltage waveform.	2	None	AC2-1
Using the scope, observe the signal delivered by a function generator.	2	None	AC2-1
Measure peak to peak voltage with oscilloscope.	2	None	AC2-1
Measure AC voltage and frequency using an oscilloscope with a calibrated horizontal sweep.	2	None	AC2-1
Solve basic trigonometric problems as applicable to electronics.	3	2, 3	AC3-3 AC3-4
Use an EVM for Testing shorted or leaky capacitors.	3	None	None
Check capacitors with a capacitor checker.	3	None	None
Measure and plot the RC time constant curve.	3	None	None
Verify experimentally the formula for capacitive reactance.	3	2	AC3-3
Measure the phase angle in a capacitive circuit.	3	2	AC3-3
Determine the value of series and parallel connected capacitors.	3	2	AC3-3
Analyze series and parallel RC circuits.	3	2	AC3-3
Analyze filter circuits.	3	3	AC3-4
Measure the frequency response of filter circuits.	3	3	AC3-4
Verify the formula $X_L = 2\pi FL$.	4	4	None

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Measure the phase angle in an inductive circuit.	4	None	None
Determine the value of series and parallel connected inductors.	4	4	AC4-3
Analyze series and parallel RL circuits.	4	4	AC4-3
Determine the turns ratio of a given transformer.	5	5	None
Measure the effect of an increase of load current on the source current and voltage.	5	5	AC5-2
Resistance test a transformer.	5	5	AC5-2
Measure power in an AC circuits.	6	6	AC6-2
Analyze RLC circuits (series, parallel, complex).	6	6, 7, 8	AC6-2 AC6-3 AC6-4
Construct RLC circuits (series, parallel, complex).	6	6, 7, 8	AC6-2 AC6-3 AC6-4
Troubleshoot RLC circuits (series, parallel, complex.)	6	6, 7, 8	AC6-2 AC6-3 AC6-4
Verify $F = \frac{1}{2\pi\sqrt{LC}}$.	6	6	AC6-2
Plot a frequency response curve for a series and parallel resonant circuit.	6	8	AC6-4
Measure the effect of circuit Q on frequence response and bandwidth in resonant circuits.	6	7	AC6-3

SEMICONDUCTOR DEVICES

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
List several applications and describe the basic construction of semiconductor diodes.	2	None	None
Identify different diode packages and their cathode and anode terminals.	2	None	None
Use an ohmmeter to determine condition of a diode and identify its cathode and anode terminals.	2	2	SD/A2-3
Investigate the characteristics of diodes by plotting their curves.	2	1	SD/A2-2
Investigate the characteristics of a zener diode voltage regulator circuit.	3	3	None
Determine maximum safe operating conditions of zener diode.	3	3	None
Design zener regulator circuits and check by building and testing.	3	3	None
Identify standard transistor packages.	5	None	SD/A5-2
Identify C-B-E leads of any transistor.	5	4	None
Explain loading effect.	5	5	None
Remove and install transistors.	5	5	None
Analyze D.C. voltages in common base, emitter and collector amplifiers.	5	5	None
Check transistors both in and out of circuits.	5	5	SD/A5-2
Use transistor checker to check transistors.	5	None	None
Use curve tracer to test transistors.	6	5	None
Measure amplifier voltage gain with an oscilloscope	6	None	None
Describe the operation and construction of JFET's and IGFET's.	7	None	None
Describe the difference in enhancement and depletion mode of IGFET's.	7	7	None

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Build and investigate the operation of different FET circuits.	7	6	None
Plot a set of characteristic curves for a given FET.	7	6	None
Explain operation and applications of the SCR, bi-directional thyristor, trigger diode, unijuction transistor and PUT.	8	8, 9	SD/A8-2 SD/A8-3
Investigate operation of unijunction transistors, and SCR's.	8	8, 9	SD/A8-2 SD/A8-3
Describe the basic function and principle of light sensitive and light emitting devices.	10	None	None
Investigate the operation of photo-transistors, light emitting diodes, and liquid crystal displays.	10	10, 11	None

ELECTRONIC CIRCUITS

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Calculate input impedance of common base, emitter, and collector amplifiers.	1	2	None
Identify thermal stability feedback loops.	1	1	None
Calculate bias voltages and currents.	1	1	None
Identify amplifier classes from schematics (A-B-AB).	1	None	None
Identify class c amps.	1	None	None
Identify the Darlington Arrangement.	2	3	None
Measure freq. response in audio amps.	2	4	None
Explain volume and tone control systems.	2	None	None
Tune output circuits.	2	4	None
Explain amplifier neutralization.	2	5	SD/A14-3
Identify differential amplifier circuits.	3	5	SD/A14-3
Recognize the schematic diagram for a comparator, summing amplifier, and filters (high and low pass).	3	6, 7, 8	SD/A14-4 SD/A14-5 SD/A14-6
Identify a voltage follower and describe its characteristics.	3	7	SD/A14-5
Calculate and measure amplifier op-amp gain.	4	10	None
Identify half and full wave rectifier configurations.	4	9	None
Identify equalization networks and filters.	4	None	None
Measure power supply ripple and regulation with an oscilloscope.	4	9	None
Identify series and shunt regulator configurations.	4	10	None
Calculate control current needed for feedback regulation.	4	10	None

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Check power supply components with an ohm meter.	4	9	None
Explain the operation of a voltage multiplier.	4	9	None
Recognize the basic types of oscillators.	5	11, 12, 13, 14	SD/A15-3 SD/A15-4 SD/A15-5 SD/A15-6
Identify the feedback networks in oscillator circuits.	5	11, 12, 13	SD/A15-3 SD/A15-4 SD/A15-5
Calculate the frequency of the basic types of oscillators.	5	11, 12, 13, 14	SD/A15-3 SD/A15-4 SD/A15-5 SD/A15-6
Explain crystal's frequency selective characteristics.	5	11	SD/A15-5
List several applications for each type of oscillator.	5	11, 13	SD/A15-3 SD/A15-5
Use an oscilloscope to examine wave forms.	6	15	SD/A16-2A SD/A16-2B
Identify the common pulse shaping circuits.	6	15	SD/A16-2A SD/A16-2B
Explain how harmonic content affects wave shape.	6	15	SD/A16-2A SD/A16-2B
Explain the operation of differentiators and and integrators.	6	15	SD/A16-2A SD/A16-2B
Set up and operate a "555" timer for astable monostable operation.	6	16	SD/A16-3A SD/A16-3B
Set up a transistor sawtooth generator.	6	17	SD/A16-4
Explain the operation of clippers, clamper, and slicers.	6	15	SD/A16-2A SD/A16-2B
Explain the characteristics of AM-FM-SSB.	7	None	None
Explain the operation of a balanced modulator.	7	None	None

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Identify and describe the basic operation of AM and FM detectors.	7	18	None
Check and adjust the AM and FM IF amps and detectors.	7	18	None
Align superhet receivers.	7	None	None

DIGITAL

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Verify the logic function of the AND/OR gate and inverter.	3	2, 3	DT3-2 DT3-3
Verify the logic function of the NAND/NOR gate.	3	4	DT3-4
Construct practical operating circuits using logic gates and inverters.	4	5, 6	DT4-3 DT4-4
Reduce logic circuits to a simpler form through the application of BOOLEAN ALGEBRA.	5	7, 8	DT5-1 DT5-2
Design and construct specific logic circuits through application of BOOLEAN ALGEBRA.	5	7, 8	DT5-1 DT5-2
Verify the logic function of a R-S Flip-Flop.	6	9	DT6-1
Verify the logic function of the TYPE-D and T FLIP-FLOPS.	6	10	DT6-2
Verify the logic function of the J-K FLIP-FLOP.	6	11	DT6-3
Construct an up-down ripple counter using J-K FLIP-FLOPS. Verify its operation.	7	12	DT7-2
Construct a BCD decade ripple counter interfaced to a BCD to decimal decoder. Verify its operation.	7	13	DT7-3
Construct and verify the operation of a PARALLEL LOAD UP-DOWN COUNTER.	7	14	DT7-4
Program a synchronous counter for various specified number of states.	7	14	DT7-4
Construct and verify the operation of a VARIABLE MODULUS SYNCHRONOUS COUNTER.	7	14	DT7-4
Construct and verify the logic function of the serial, parallel, and recirculating shift registers.	7	15	DT7-6
Construct a SYNCHRONOUS AND ASYNCHRONOUS circuit to transmit digital data. Verify the operation using a scope and logic probe.	7	12	DT7-2
Construct a SHIFT RIGHT/LEFT REGISTER. Verify its operation and capability to multiply or divide by shifting data.	7	12	DT7-6

TASK	TEXTBOOK UNIT NO.	HEATH LAB. NO.	MISSOURI LAB NO.
Verify the complementing function of a shift register	7	15	DT7-6
Construct and verify the operation of a RING COUNTER AND TWISTED-RING COUNTER.	7	16	DT7-7
Construct and verify the operation of a shift register generator.	7	17	DT7-8
Verify the proper operation of an encoder logic circuit for various combinations of binary to decimal numbers.	8	18	DT8-2
Construct a BCD to decimal decoder. Verify its operations through signal tracing.	8	18	DT8-2
Construct a parity bit detector circuit.	8	22	DT8-7
Construct a PARALLEL-TO-SERIAL and SERIAL-TO-PARALLEL CONVERTER. Verify the logic function.	8	20	DT8-4
Construct a half-adder and full-adder logic circuit. Verify the operation of each.	8	21	DT8-6
Construct a half-subtractor and full-subtractor logic circuit. Verify the operation of each.	8	21	DT8-6
Construct an added-subtractor logic circuit. Verify its operation.	8	22	DT8-7

MICROPROCESSOR

T/A/S NO.	TASK	TEXTBOOK UNIT NO.	HEATH LAB NO.
ET-001	Convert Between Decimal and Binary and Between Hexadecimal and Decimal Numbers	1	1 and 2
ET-002	Draw a Block Diagram of a Hypothetical Microprocessor	2	None
ET-003	Write a Simple Straight Line Program Using Keyboard Functions	2	3
ET-004	Perform Arithmetic and Logic Operations on Binary Numbers	3	4
ET-005	Develop Flow Charting for Programming	4	None
ET-006	Write and Execute a Program Containing Branch Instructions	4	5
ET-007	Write and Execute Programs Illustrating Multiple-Precision Arithmetic Operations	4	6
ET-008	Write and Execute Programs Using Extended and Indexed Addressing	5	7
ET-009	Load and Execute a Memory Block Move Program	6	9
ET-010	Demonstrate Reset and Interrupt Sequences	6	10
ET-011	Interface and Access Memory	7	11, 12, and 13
ET-012	Interface to Display Devices	7	14
ET-013	Interface a Keyboard to a Microprocessor	8	15
ET-014	Utilize a Peripheral Interface Adaptor to Interface Standard Devices	8	16, 17, and 18
ET-015	Use Analog to Digital and Digital to Analog Conversion Techniques for Signal Conversion	*1	19

*Microprocessor Interfacing

INSTRUCTIONAL MATERIALS LIST

BOOKS

THE FOLLOWING BOOKS MAY BE PURCHASED FROM

Heathkit/Zenith
Technical Training Aids
P.O. Box 26042
Birmingham, AL 35216
Phone: 205-822-1326

D.C. Electronics, Student Textbook, EB-6101, 1983.	($19.95)
D.C. Electronics, Student Workbook, EB-6101-40, 1983.	($10.95)
D.C. Electronics, Instructor's Guide, EB-6101-50, 1984.	($9.95)
A.C. Electronics, Student Textbook, EB-6102, 1984.	($19.95)
A.C. Electronics, Student Workbook, EB-6102-40, 1983.	($10.95)
A.C. Electronics, Instructor's Guide, EB-6102-50, 1983.	($9.95)
Semiconductor Devices, Student Textbook, EB-6103, 1983.	($19.95)
Semiconductor Devices, Student Workbook, EB-6103-40, 1983.	($10.95)
Semiconductor Devices, Instructor's Guide, EB-6103-50, 1984.	($9.95)
Electronic Circuits, Student Textbook, EB-6104, 1981.	($19.95)
Electronic Circuits, Student Workbook, EB-6104-40, 1983.	($10.95)
Electronic Circuits, Instructor's Guide, EB-6104-50, 1984.	($9.95)
Digital Techniques, Student Textbook, EB-6201, 1983.	($24.95)
Digital Techniques, Student Workbook, EB-6201-40, 1983.	($11.95)
Digital Techniques, Instructor's Guide, EB-6201-50, 1983.	($9.95)
Microprocessors, Student Textbook, EB-6401, 1983.	($24.95)
Microprocessors, Student Workbook, EB-6401-40, 1983.	($11.95)
Microprocessors, Instructor's Guide, EB-6401-50, 1982.	($9.95)
Microprocessor Interfacing, Student Textbook, EB-6402, 1983.	($24.95)
Microprocessor Interfacing, Student Workbook, EB-6402-40, 1982.	($10.95)
Microprocessor Interfacing, Instructor's Guide, EB-6402-50, 1982.	($9.95)

Instructional Materials List, (con't)

THE FOLLOWING MANUALS MAY BE PURCHASED FROM

University of Missouri-Columbia
Instructional Materials Laboratory
10 Industrial Education Building
Columbia, MO 65211
Phone: 314-882-2883

D.C. Electronics, Assignment Workbook/Lab Manual, IE-41-W.	($1.65)
A.C. Electronics, Assignment Workbook/Lab Manual, IE-42-W.	($1.65)
Semiconductor Devices/Applications Volume I, Assignment Workbook/Lab Manual, IE-43-W.	($1.65)
Semiconductor Devices/Applications Volume II, Assignment Workbook/Lab Manual, IE-53-W.	($1.65)
Digital Techniques, Volume I and II, Assignment Workbook/Lab Manual, IE-52-W.	($1.65)
Electronics Manual for Instructors, IE-44-I.	($15.00)
Semiconductor Devices/Applications Volume II, Instructor's Key, IE-53-K.	($2.20)
Digital Techniques, Volume I and II, Instructor's Supplement, IE-52-I.	($2.20)

VISUAL AIDS

Heathkit/Zenith, Microprocessors, EE-3401-1, 1978.

EQUIPMENT LIST

The following equipment represents the minimal amount needed to perform the laboratory experiments. The equipment is divided into groups that coincide with the units in the Electronic Technician Curriculum.

D-C

Heathkit ET-3100B Electronic Design Experimenter, OR:

--A power supply capable of producing 0 to +18 volts DC at 100 milliamperes
--A power supply capable of producing 0 to -18 volts DC at 100 milliamperes
--Some method of interconnecting electronic components

In addition a voltmeter, ohmmeter, and ammeter are required.

A-C

Heathkit ET-3100B Electronic Design Experimenter, OR:

--A power supply capable of producing 0 to +18 volts DC at 100 milliamperes.
--A power supply capable of producing 0 to -18 volts DC at 100 milliamperes.
--An audio signal generator capable of producing sine and square waves at frequencies from 200 Hz to 20 kHz.
--A source for 15 VAC and 30 VAC at 60 Hz.
--A method of interconnecting electronic components.

In addition a voltmeter, ohmmeter, and ammeter are required.

SEMICONDUCTOR

Heathkit ET-3100B Electronic Design Experimenter, OR:

--A power supply capable of producing 0 to +18 volts DC at 100 milliamperes
--A power supply capable of producing 0 to -18 volts DC at 100 milliamperes
--An audio signal generator capable of producing frequencies from 200 Hz to 20 kHz
--A source for 15VAC and 30VAC at 60 Hz

A method of interconnecting electronic components

ELECTRONIC CIRCUITS

Heathkit ET-3100B Electronic Design Experimenter, OR:

--A power supply capable of producing 0 to +18 volts DC at 100mA.
--A power supply capable of producing 0 to -18 volts DC at 100mA.
--An audio signal generator capable of producing sine and square waves at frequencies of 200 Hz to 20 kHz.

--A source of 15 VAC and 30 VAC at 60 Hz.
--A method of interconnecting electronic components (such as a solderless breadboarding socket).

In addition a voltmeter, ohmmeter, and oscilloscope are required.

DIGITAL

Heathkit ET-3200B Digital Design Experimenter, OR:

--Power Supplies
  +12V at 100mA
  -12V at 100mA
  +5V at 500mA
--Pulse Generator with TTL compatible outputs of:
  1Hz, 60Hz (line), 1kHz, and 100kHz.
--Four logic switches
--Two "debounced" switches
--Four LED indicators
--Solderless breadboarding socket that will hold up to eight 16-pin dual-in-line ICs.

MICROPROCESSORS

ET-3400A Microprocessor Trainer.

ADDITIONAL ITEMS NEEDED:

Frequency Counter
Digital Multimeter

ADDRESSING STUDENTS WITH SPECIAL NEEDS

Identifying Students with Special Needs

Formulating a Basic Approach to Teaching

Using Special Strategies

Redirecting Teaching Strategies Usually Used

ADDRESSING STUDENTS WITH SPECIAL NEEDS

Some students may need special help in achieving competency. Ideas are presented here to help in identifying those students and in modifying materials and techniques to help them succeed.

Identifying Students with Special Needs

Generally speaking, those students who cannot succeed in the regular vocational education programs without special help are termed "students with special needs" (Vocational Education Act of 1963 and Amendments). Persons most likely to be identified as students with special needs are the academically and economically disadvantaged and the handicapped--the mentally retarded, deaf and hard of hearing, speech impaired, emotionally disturbed, orthopedically (physically) impaired, health impaired, and learning disabled.

The handicapped are further identified as those (1) with a physical or mental disability that substantially impairs one, or more, major life activity--walking, seeing, hearing, speaking, working, or learning; (2) who have a record or history of such impairment or condition; and (3) who are regarded as having an impairment (Rehabilitation Act of 1973). Women, minorities, the limited English speaking, and others likely to be underemployed or striving for equal opportunity in employment, when meeting the criteria for academic or economic deprivation, are specifically identified in the disadvantaged group to be given special help.

Formulating a Basic Approach to Teaching

Society recognizes the right of every individual to an appropriate education, and the law mandates giving persons with special needs an equal chance. In brief:

1. The Vocational Education Amendments of 1976 give special emphasis to developing and providing programs of vocational education for "those with special educational handicaps" and they provide for the allocation of moneys to do so.

2. The Education for All Handicapped Children Act of 1975 assures that all handicapped children between the ages of three to twenty-one have available to them a free, appropriate public education which relates to their unique needs and is provided in the least restrictive environment.

3. The Rehabilitation Act of 1973 prohibits discrimination on the basis of handicap in any program or activity receiving federal financial assistance and directs employers to take affirmative action in hiring handicapped people.

4. The Education Amendments of 1972 prohibit discrimination on the basis of sex in educational programs receiving or benefiting from federal financial assistance.

5. The Civil Rights Act of 1964 prohibits discrimination in employment on the basis of sex, race, color, religion, or national origin in any program or activity receiving federal financial assistance--including training for employment.

We must then, provide equal opportunity to learn in our instructional processes.

Basically, an approach to teaching which recognizes individual differences in all students provides the best atmosphere for disadvantaged and handicapped students. This approach allows students to work at different rates; involves large-group, small-group, and individual instruction; incorporates a variety of instructional materials, media, and teaching techniques; and involves a variety of learning activities--reading, doing, discussing, listening, viewing, experiencing, sharing, cooperating, relating, using the senses, etc. It gives disadvantaged and handicapped students the dignity of exploring, learning, and facing the same experiences and responsibilities as other students without limiting their possibilities by stereotyped concepts of what they can or cannot do.

It involves being organized, with students completely familiar with the teaching/learning plan. When beginning a CBVE class, for example, explain what learning to attain competencies means, how the students will carry out their work, how to use the materials, where to find materials, how and when tests will be given, how "passing" or competency is determined, and what your role as a teacher is.

It also means teacher direction of those students who are not self-directed learners--those with poor academic backgrounds who thrive on teacher interaction and need immediate feedback; instruction simplified; procedures modified; social development, as well as specific job skills; role models; or other special aid. For these students, the learning activities described in the materials may become the teacher's lesson plan and utilized in large-group and small-group settings before the individual student attempts doing learning activities alone. The teacher-directed class might proceed as follows: teacher introduction to tasks to be performed, explanation of what is to be learned and why, presentation of information in small chunks, demonstration of how, student tryout and practice, time for questions and answers, trial test followed by reteaching, and evaluation. The teacher will employ a variety of strategies to address the learning needs and styles of the student.

Using Special Strategies

In order to determine the most appropriate teaching strategies, assess the class for kinds of special help required, and develop a plan for meeting any unique needs. Refer to Mainstreaming Guidebook for Vocational Educators by Dahl, Appleby, and Lipe, Olympus Publishing Company, Salt Lake City, Utah 84105, for modifications and general classroom strategies for meeting the unique needs of the different handicapped populations.

Also, enlist the advice and help of employers, support personnel, and agencies and organizations serving disadvantaged and handicapped populations in your school system and geographic area.

Redirecting Teaching Strategies Usually Used

Many of the strategies usually used with regular students may be redirected or modified and also provide effective learning activities for students with special needs. An explanation of how this may be done follows.

AUDIO-VISUALS (films, filmstrips, slide/tape, videotapes, and ETV and commercial television programs). The combination of sight and sound provides more effective communication then either sight or sound alone. Audio-visuals may be used to supplement or replace other methods of presenting information. The hearing impaired will require captioning, signing, or a printed script written at the appropriate reading level or presenting only essential details. The visually impaired may glean information from the sound source, but additional explanation will need to be provided for any visual display of information which is not explained adequately by the narration. Some audio-visual presentations, particularly 8mm and 16mm films, may move too fast for the information to be grasped and need to be evaluated with this in mind.

CONTACT WITH WORK ENVIRONMENT. Handicapping conditions, limited finances, geographic isolation, cultural difference, limited communication skills, and social isolation have caused disadvantaged and handicapped persons to have little contact with the world of work. Familiarity with the work setting in which a particular job takes place, relationships with other workers, business use of the telephone, relationship of one's job to other jobs in the same business are just a few examples of areas where special students may require special exposure by means of field trips, spending a day on the job, viewing films, or having additional training sessions.

NOTE: For those with physical impairments, field trips, on-site job observations, and work experience opportunities will be limited to "accessible" businesses in the community. Before deciding where to go, determine whether the facilities are accessible.

DEMONSTRATION AND TRYOUT. Demonstration by teacher, experienced workers, and previously trained students provide reliable role models for learners. Steps, procedures, precautions, physical manipulation, and techniques are imprinted visually in the order and at the time they should occur in task performance. Immediate tryout of the task following the demonstration or an immediate attempt of each step, technique, or procedure as it is demonstrated provides students direct involvement, permits correction and clarification, and promotes retention. Tryout also identifies areas in performance steps, techniques, tools, and work environment where handicapped students need to have modification in order to perform tasks and meet industry standards.

ELIMINATION OF STEREOTYPING. Disadvantaged and handicapped people face more than the sex role stereotyping myths in their quest for employment. The following are just a few examples: "Deaf people are dumb." "The best job for blind people is tuning pianos." "He'll never be able to do that; he's a cripple." "Mr. _____ was no good; so will be his son." "She can never do that; her parents didn't go to college." In addition to overcoming the unfounded assumptions of others, disadvantaged and handicapped

often have equal misconceptions about themselves thinking: "I can never do that." "_____, who is deaf, does assembly line work; that's what I'll do, too." "I'll never be anybody."

Overcoming stereotyping may begin with using sex fair instructional materials and media, exploring interests and abilities, exploring two or three nontraditional jobs, or complimenting accomplishments. It may include planning how to reach an educational goal, providing role models (person with like handicap or socioeconomic background who has succeeded), as well as observing persons in nontraditional work roles. It means doing whatever raises aspirations and increases self-worth. It means attempting to eliminate underemployment.

EMPLOYER INVOLVEMENT. Programs with employer input are more practical and in line with the current needs of the job market. Employers who make input feel a special kinship to the program and get a chance to see the students before meeting them in the job market.

For disadvantaged and handicapped students, employer involvement offers a very special opportunity to remove common misconceptions about their capabilities. It enables employers to help with any modification needed, see students performing tasks, and observe how the students relate to others. It gives students a chance to prove that they can do the work, that they will not endanger themselves or others, and that they will not increase expenses. These are major employer concerns. Both students and teachers should be prepared to provide reassuring answers and evidence to show there is no more risk than with the nonhandicapped.

Employers may be involved by giving class presentations; giving suggestions for program improvement and modifications; conducting mock interviews; and providing work experience, observations and worker interviews, job analysis, etc.

HANDS-ON EXPERIENCES: PROBLEM SOLVING: PERSONAL INVOLVEMENT (work samples, tryout exercises, games, role playing). Being involved in a sample of work through completing a product, performing related paper work, or role playing interpersonal relationships on the job keeps students interested, holds attention to the learning tasks, and injects the realities of working and job performance in the teaching/learning situation. It makes the student feel that the instruction is practical and valuable. Accomplishment means "qualified for work"--a great boost to self-esteem for those who doubt self-worth.

The instructor and other students should avoid taking over when handicapped students are awkward or slow in completing a task. The student cannot master the skill if someone else does it.

ILLUSTRATIONS (pictures, graphs, bulletin boards, transparencies, and other visuals). The disadvantaged, the mentally retarded, and the hearing impaired, particularly, are especially oriented to visual methods of learning. Other students, with the exception of the blind and some visually impaired, will appreciate visual presentation of information to be learned. Student handouts, with the steps to a task illustrated and

briefly and simply explained, are especially helpful. Captioning and brief explanations are important supplements. Many illustrations may be adapted for the visually impaired by making them tactile (so that they can be felt). Sometimes enlarged print and bold outlines help.

INTERACTION: INDEPENDENCE. Economic deprivation, geographic isolation, cultural isolation, and restrictions on mobility and social relationships imposed by physical impairments have limited the experiences of the disadvantaged and the handicapped in the community at large. Many have no previous work experience, little observation of the worker's daily routine, and limited social experiences. They have been sheltered at home; absent from the scene; at best onlookers.

So that they will not continue in this role after vocational training, experiences in the community and involvement with nonhandicapped people and other students are of utmost importance. These students, as well as their families and the working community, need proof that they can function independently and competently. They need to establish contacts who can serve as references to recommend them as competent workers who can relate to others.

Field trips, worker interviews, cooperative work experience, spending a day on the job, giving talks before civic groups are, therefore, important to the acclimation of disadvantaged and handicapped students to the world of work. Participating on team-work projects with other students; pairing with a slower or faster learning peer; pairing with a nonhandicapped, a nondisadvantaged, or person from another race or culture will help foster understanding and promote learning communication skills. Teaching special units dealing with related communication and social skills will also be necessary; for example: office etiquette, relationships with employer and other employees, daily work expectations which are not direct task performance, telephone skills, appropriate dress and grooming habits, to name a few.

LISTENING (explaining, discussing, reacting orally). Learning by listening is an important tool to the disadvantaged, the visually impaired, speech impaired, learning disabled, and others who "prefer to be told" or "have to be told" rather than read about it.

The visually impaired require identification of familiar sounds in the work place to determine location of different work areas, equipment functions, and hazards. The hearing impaired require sight substitutions, such as indicator lights, for critical sounds they cannot hear. They may use lip reading, interpreting, and sound conduction or amplification devices. The retarded need to become accustomed to the sounds of the work place so that they can work without being distracted. The speech impaired need to be accorded the right to listen although they may have trouble participating, or not be able to participate orally.

When information is presented for listening, instruction in how to listen (what to listen for) is important. An outline of the information presented, supplemented by visuals, tryout exercises, demonstrations,

completion of questions to be answered, analysis of cases or problem situations, or other application activities will enhance use and retention of information heard.

Listening is a vocational skill as well as a learning skill. Workers must be able to receive information by listening as well as to provide information for listening. Most on-the-job instruction is given orally. Explanation must be given to and received from customers, co-workers, and supervisors.

READING HELPS. Being fluent in the technical vocabulary or language of the job and being able to read at the level required by the job is a part of occupational competency. On-the-job reading requirements may vary from the reading of signs to following instructions given in technical manuals. The instruction given in reading, then, for vocational purposes, will depend on the reading skills possessed by the student and the reading requirements of the job. Whether or not a supplemental class in remedial reading is offered, the vocational instructor will find providing reading helps also helps provide job skill.

Braille materials, large print textbooks, magnifying devices, and recordings may be provided for the visually impaired. Materials may be simplified or outlined for the hearing impaired and others with limited language skills. The native language may be supplied above the English for critical information in textbooks used by the limited English-speaking. Familiarity with the setting in which the printed information is applied may be given via field trips, demonstrations, or films to make reading easier and more meaningful.

Students with exceptional reading problems may require the help of a special reading teacher or be enrolled in a remedial reading program. Some schools employ vocational reading teachers to assist vocational students with developing vocational reading skills and doing the reading required in their programs.

RECORDING AND RECORDINGS (tapes, records, radio programs). Information may be presented and gained by listening to recorded information rather than by reading. This strategy will aid the nonreader, the poor reader, the visually impaired, the learning disabled, and others through use as a variation of teaching technique. Recording is also a useful tool for the deaf in notetaking; the recording script may be transcribed into print later by a hearing individual. It will also provide instruction for those who have missed initial classroom presentation of information or who need review. Recordings may be supplemented by slides and pictures.

RELATED MATH. Competency in math, like competency in reading, is more critical to some jobs than to others. Math is best taught in relation to the task of which it is a part. This instruction should incorporate basic math and remedial math instruction as needed. A cooperative or team-teaching effort with the math teachers or related math instructors in the school will relieve the burden on the vocational instructor. Enough practice and application exercises should be provided to insure retention

of the math operations involved. It is helpful to compile a list of the math competencies needed to complete the training program; prepare an assessment test to determine student skills; and plan, in the beginning, a program which the student can follow to attain the basic math competencies prerequisite to the course. If the skills cannot be acquired simultaneously to the job-skill training program, the student should postpone entry into the course until the prerequisite skills are attained. It may be necessary to prepare a special manual and exercises to provide the related math instruction.

REMEDIAL AND RETENTION EXERCISES. Doing learning activities does not necessarily make students occupationally competent. Performance must be observed, misunderstandings clarified, procedures and techniques corrected, and repetition called for at a future time. Lesson planning should anticipate theory and tasks with which students are likely to have difficulty, include additional practice exercises, and provide alternate approaches to teaching. Repetition for retention should be provided, such as repetition of information in different media presentations or use of different types of application exercise. Review sessions, keeping notebooks, completing work samples, doing live work, and solving cases will also help.

SAFETY. The Occupational Safety and Health Act has increased employer concern for safety and underscored the importance of providing safety instruction along with task performance. It is especially important for the handicapped in two ways: (1) to overcome employer concern about the handicapped person's ability to take care of himself/herself and not endanger the lives of others; (2) to identify and deal with situations which are hazardous for persons because of particular handicaps.

To meet these needs for safety instruction, the handicapped student not only needs the basic or general safety instruction related to the occupation but safety instruction or special safety provisions needed for a person with his/her particular handicap. An example is the installation of a blinking light to tell a person who is deaf that equipment is running.

NOTE: The Kentucky Department of Labor, Occupational Safety and Health Program, Division of Education and Training, Frankfort, Kentucky 40601, Phone: (502) 564-6895, offers training programs to help vocational instructors teach safety.

SUPPORT SERVICES. Some students will require emotional, social and financial support in order to succeed in the instructional programs. Others will need career counseling and special assistance in becoming employed. Government agencies, special schools, special personnel, and organizations for disadvantaged and handicapped persons can provide this help. The following are examples and should not be considered an all-inclusive list: resource room teachers, rehabilitation counselors, guidance counselors, tutors, remedial teachers, instructors in special schools, occupational therapists, diagnostic specialists, media personnel, handicapped workers, workers who are members of a minority group, social

workers, and others who can serve as role models. Survey the community to identify who serves the needs of disadvantaged and handicapped persons in your area and incorporate their assistance in related learning activities.

UNIQUE MODIFICATIONS (modified equipment, tools, learning aids, changes in work environment, adaptations in course or training program content). Some students require special help in meeting physical job requirements. When considering modification, it is important to concentrate on what the student can do. If at all possible, enable the student to function in the work environment as it is usually found. Employers look favorably on handicapped persons with this kind of preparation.

Rehabilitation centers; organizations and schools for the blind, deaf, dyslectic, disabled, and mentally handicapped; and publishers and manufacturers of special instructional materials, aids, and equipment can offer aid in meeting unique needs. Consultation with special education personnel and rehabilitation counselors is a good starting point. The student should also be asked to make suggestions.

Care should be taken to insure occupational competency. Prospective employers should be shown how the modification operates in the work setting and how it increases efficiency.

The previously described list of strategies is not exhaustive. Others may be added. All will need to be directed toward the occupation for which training is being given, the students enrolled, the availability of instructional materials, and the community. It is also important to remember that what works well for one group of students or a particular student will not necessarily work well for another.

CONVERT BETWEEN DECIMAL AND BINARY AND BETWEEN HEXADECIMAL AND DECIMAL NUMBERS

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiments 1 and 2, and the materials required:

1. Enter a program into the microprocessor trainer and convert between decimal and binary numbers.

2. Enter a program into the microprocessor trainer and convert between hexadecimal and decimal numbers.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--Unless you have a good foundation in numbers and codes you will never attain an understanding, or be able to fully make use of a microprocessor.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
CONVERT BETWEEN DECIMAL AND BINARY AND BETWEEN HEXADECIMAL AND DECIMAL NUMBERS	5

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 1 in Student Workbook, MICROPROCESSORS.

2. Perform Lab Experiment 2 in Student Workbook, MICROPROCESSORS.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th printing Heath Company, Benton Harbor, MI, 1983.

Graf, Modern Dictionary of Electronics, 5th edition. Howard W. Samsand Co., Inc., Indianapolis, IN, 1982.

CONVERT BETWEEN DECIMAL AND BINARY AND BETWEEN HEXADECIMAL AND DECIMAL NUMBERS

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about number systems and codes.	MICROPROCESSORS, Book 1	
2	Have the student complete each "Self-Test Review" as they progress through the reading in LA 1.	MICROPROCESSORS, Book 1	
3	Have the student complete Unit 1 Exam. You may have an additional test or project you want the student to take at this time.	Student Workbook, MICROPROCESSORS	
4	Have the student define in writing each of the words on the Vocabulary Sheet. They may use an Electronics Dictionary.	Modern Dictionary of Electronics.	
5	Have the student perform the Check-Out Activities. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --Heathkit Lab Experiments 1 and 2 --Materials listed in the Lab Experiments or a substitute --Instructor's Final Checklist	

DRAW A BLOCK DIAGRAM OF A HYPOTHETICAL MICROPROCESSOR

OBJECTIVES

Provided access to reference materials:

1. Draw a block diagram of a hypothetical microprocessor.
2. Trace the data flow that takes place during the fetch and execute cycle of a simple program.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--It is important to know how the circuits work together in sequence in order to program and use a microprocessor.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
DRAW A BLOCK DIAGRAM OF A HYPOTHETICAL MICROPROCESSOR ..	5, 8

CHECK-OUT ACTIVITIES

1. Draw a block diagram of a hypothetical microprocessor.
2. Trace the data flow that takes place during the fetch and execute cycle of a simple program.

SUGGESTED REFERENCE

Heath Company, Microprocessors Book 1, and student workbook, Microprocessors, 19th printing. Heath Co., Benton Harbor, MI, 1983.

Graf, Modern Dictionary of Electronics, 5th Ed. Howard W. Sams and Co., Indianapolis, IN, 1982.

DRAW A BLOCK DIAGRAM OF A HYPOTHETICAL MICROPROCESSOR

I.A#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student define in writing each of the words on the Vocabulary Sheet. They may use their text book and electronics dictionary.	Microprocessors, Book 1 Modern Dictionary of Electronics	
2	Have the student read about microprocessors.	Microprocessors, Book 1	
3	Have the student view a slide-tape presentation about microprocessors.	Slide-Tape, "Introduction to Microprocessors"	
4	Have the student complete "Self-Test Reviews" at the end of LA 2.	Microprocessors, Book 1	
5	Have the student perform Check-Out Activity 1. Use the Instructor's Final Checklist to evaluate the student.	--Instructor's Final Checklist	
6	Have the student read about executing a program.	Microprocessors, Book 1	
7	Have the student complete "Self-Test Reviews" at the end of LA 5.	Microprocessors, Book 1	
8	Have the student perform Check-Out Activity 2. Use the Instructor's Final Checklist to evaluate the student.	--Instructor's Final Checklist	

WRITE A SIMPLE STRAIGHT LINE PROGRAM USING KEYBOARD FUNCTIONS

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 3, and the materials required, write a simple straight line program using keyboard functions. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--It is very important to have a complete understanding of simple programs because your comprehension of microprocessors is based upon an understanding of programs and data flow.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
WRITE A SIMPLE STRAIGHT LINE PROGRAM USING KEYBOARD FUNCTIONS	4

CHECK-OUT ACTIVITY

Perform Lab Experiment 3 in Student Workbook, Microprocessors.

SUGGESTED REFERENCE

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th Printing. Heath Co., Benton Harbor, MI, 1983.

WRITE A SIMPLE STRAIGHT LINE PROGRAM USING KEYBOARD FUNCTIONS

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student define in writing each of the words on the vocabulary sheet.	Student Workbook, Microprocessors	
2	Have the student review the reading assignment about microprocessors and executing a program.	Microprocessors, Book 1	
3	Have the student complete Unit 2 examination, Microcomputer Basics.	Student Workbook, Microprocessors	
4	Have the student perform the Check-Out Activity. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor Trainer --Heathkit Lab Experiment 3 --Instructor's Final Checklist	

PERFORM ARITHMETIC AND LOGIC OPERATIONS ON BINARY NUMBERS

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 4, and the materials required, perform arithmetic and logic operations on binary numbers. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--All programming is based on the use of numbers and mathematics. In order to use the microprocessor, an understanding of basic arithmetic and logic operations using binary numbers is essential.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
PERFORM ARITHMETIC AND LOGIC OPERATIONS ON BINARY NUMBERS	9

CHECK-OUT ACTIVITY

Perform Lab Experiment 4 in Student Workbook, Microprocessors.

SUGGESTED REFERENCE

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th printing. Heath Company, Benton Harbor, MI, 1983.

Graf, Modern Dictionary of Electronics, 5th Ed. Howard W. Sams and Co., Inc., Indianapolis, IN, 1982.

PERFORM ARITHMETIC AND LOGIC OPERATIONS ON BINARY NUMBERS

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about binary arithmetic.	Microprocessors, Book 1	
2	Have the student define in writing each of the words on the Vocabulary Sheet.	Vocabulary Sheet	
3	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessors, Book 1	
4	Have the student read about two's complement arithmetic.	Microprocessors, Book 1	
5	Have the student complete the "Self-Test Review" at the end of LA 4.	Microprocessors, Book 1	
6	Have the student read about boolean operations.	Microprocessors, Book 1	
7	Have the student complete the "Self-Test Review" at the end of LA 6.	Microprocessors, Book 1	
8	Have the student complete unit 3 Examination.	Student Workbook, Microprocessors	
9	Have the student perform the Check-Out Activity. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor Trainer --Heathkit Lab Experiment 4 --Instructor's Final Checklist	

DEVELOP FLOW CHARTING FOR PROGRAMMING

OBJECTIVE

Provided an arithmetic operation to be performed, first construct a flowchart, then from the flowchart write a program that the computer can execute. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--The ability to recognize the pattern of control flow in microprocessor applications is very important to the electronic technician. Flowcharts often simplify this task.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
DEVELOP FLOW CHARTING FOR PROGRAMMING.....	4

CHECK-OUT ACTIVITY

Obtain the necessary supplies and lab activity sheet from your instructor. Construct a flowchart, and write and execute a program to perform the desired arithmetic operation.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 1, 19th Printing. Heath Co., Benton Harbor, MI, 1983.

Heathkit/Zenith, Microprocessors, EE-3401-1. Heath Co., Benton Harbor, MI, 1978.

DEVELOP FLOW CHARTING FOR PROGRAMMING

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about algorithms and developing flowcharts.	Microprocessors, Book 1	
2	Have the student view a slide-tape presentation about microprocessors and flowcharts. You may also use the flipchart from Heathkit if it is available.	Slide-tape, "Interpretive Language"	
3	Have the student practice tracing and constructing flowcharts for the various programs in the text.	Microprocessors, Book 1	
4	Have the student perform the Check-Out Activities. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --Lab Activity Sheet with specific arithmetic operation to be performed --Instructor's Final Checklist	

WRITE AND EXECUTE A PROGRAM CONTAINING BRANCH INSTRUCTIONS

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 5, and the materials required:

> Write and execute a program that will divide by repeated subtraction. The program must incorporate an unconditional branch and a conditional branch instruction.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--Major concerns in microprocessor applications are execution time and space requirements. These can be reduced through the use of proper programming routines such as branching.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
WRITE AND EXECUTE A PROGRAM CONTAINING BRANCH INSTRUCTIONS.....	8

CHECK-OUT ACTIVITY

Perform Lab Experiment 5, steps 20-22 in student workbook, Microprocessors.

SUGGESTED REFERENCE

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th printing. Heath Company, Benton Harbor, MI, 1983.

WRITE AND EXECUTE A PROGRAM CONTAINING BRANCH INSTRUCTIONS

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about unconditional branching.	Microprocessors, Book 1	
2	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessors, Book 1	
3	Have the student read about conditional branching.	Microprocessors, Book 1	
4	Have the student complete the "Self-Test Review" at the end of LA 3.	Microprocessors, Book 1	
5	Have the student read about developing programs using algorithms.	Microprocessors, Book 1	
6	Have the student complete the "Self-Test Review" at the end of LA 5.	Microprocessors, Book 1	
7	Have the student perform Lab Experiment 5, steps 1-19, for practice.	Student Workbook, Microprocessors	
8	Have the student perform Check-Out Activity 1. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor Trainer --Heathkit Lab Experiment 5 --Materials listed in the Lab Experiment or a substitute --Instructor's Final Checklist.	

WRITE AND EXECUTE PROGRAMS ILLUSTRATING MULTIPLE-PRECISION ARITHMETIC OPERATIONS

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 6, and the materials required:

1. Write and execute a program that will perform multiple-precision subtraction.

2. Write and execute programs that use the ASLA and DAA instructions.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--The proper design and use of software can greatly increase the capabilities of a microprocessor. Multiple-precision arithmetic routines are a must for most operations.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
WRITE AND EXECUTE PROGRAMS ILLUSTRATING MULTIPLE-PRECISION ARITHMETIC OPERATIONS	4

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 6, Steps 11-13.

2. Perform Lab Experiment 6, Steps 14-26.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th. printing. Heath Company, Benton Harbor, MI, 1983.

WRITE AND EXECUTE PROGRAMS ILLUSTRATING MULTIPLE-PRECISION ARITHMETIC OPERATIONS

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about multiple-precision arithmetic.	Microporcessors, Book 1	
2	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessors, Book 1	
3	Have the student perform Lab Experiment 6, steps 1-10, for practice.	--Microprocessor trainer --Heathkit Lab Experiment 6 --Materials listed in the Lab Experiment or a substitute	
4	Have the student perform the Check-Out Activities. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --Heathkit Lab Experiment 6 --Materials listed in the Lab Experiment or a substitute. --Instructor's Final Checklist	

WRITE AND EXECUTE PROGRAMS USING EXTENDED AND INDEXED ADDRESSING

OBJECTIVE

Provided access to a micro processor trainer, Heathkit Lab Experiment 7, and the materials required, write and execute programs that utilize extended and indexed addressing. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--The real power of a microprocessor depends largely on proper software design. One such design is the use of extended and indexed addressing to utilize available memory locations.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
WRITE AND EXECUTE PROGRAMS USING EXTENDED AND INDEXED ADDRESSING	9

CHECK-OUT ACTIVITY

Perform Lab Experiment 7, steps 17 through 25.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 1 and Student Workbook, Microprocessors, 19th. Printing. Heath Company, Benton Harbor, MI, 1983.

WRITE AND EXECUTE PROGRAMS USING EXTENDED AND INDEXED ADDRESSING

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about the Architecture of the 6800 MPU.	Microprocessors, Book 1	
2	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessors, Book 1	
3	Have the student read about the instruction set of the 6800 MPU.	Microprocessors, Book 1	
4	Have the student complete the "Self-Test Review" at the end of LA 3.	Microprocessors, Book 1	
5	Have the student read about extended and indexed addressing.	Microprocessors, Book 1	
6	Have the student complete the "Self-Test Review" at the end of LA 5.	Microprocessors, Book 1	
7	Have the student Perform Lab Experiment 7, Steps 1-16, for practice	--Microprocessor trainer --Heathkit Lab Experiment 7 --Materials listed in the Lab Experiment, or a substitute	
8	Have the student complete Unit 5 Examination.	Student Workbook, Microprocessors	
9	Have the student perform the Check-Out Activity. Use the Instructor's Final Checklist to evaluate the student	--Microprocessor trainer --Heathkit Lab Experiment 7 --Materials listed in the Lab Experiment, or a substitute --Instructor's Final Checklist	

LOAD AND EXECUTE A MEMORY BLOCK MOVE PROGRAM

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab experiment #9, and the materials required, load and execute a program that uses the stack and indexing to move a list from one place in memory to another. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--In order to program and retrieve data from the Microprocessor - you must be able to use programs that will move this data when desired.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
LOAD AND EXECUTE A MEMORY BLOCK MOVE PROGRAM	3

CHECK-OUT ACTIVITY

Perform Lab Experiment 9 in the Student Workbook, Microprocessors.

SUGGESTED REFERENCE

Heath Company, Microprocessors, Book 2 and Student Workbook, Microprocessors, 19th. Printing. Heath Company, Benton Harbor, MI, 1983.

LOAD AND EXECUTE A MEMORY BLOCK MOVE PROGRAM

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student study about cascade and memory stack operations.	Microprocessors, Book 2	
2	Have the student complete the "Self-test Review" at the end of the reading assignment in LA 1.	Microprocessors, Book 2	
3	Have the student perform the Check-Out Activity.	--Microprocessor trainer --Heathkit Lab Experiment 9 --Materials listed in Lab Experiment, or a Substitute	
	Use the Instructor's Final Checklist to evaluate the student.	--Instructor's Final Checklist	

DEMONSTRATE RESET AND INTERRUPT SEQUENCES

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 10 and the materials required:

1. Draw flow charts depicting the sequence of events that occur during reset, NMI, IRQ, and SWI.

2. Demonstrate the use of subroutines.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--The art of flow charting the events in programming and check-out of MPU circuits will enhance your understanding of the system.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
DEMONSTRATE RESET AND INTERRUPT SEQUENCES.....	8

CHECK-OUT ACTIVITIES

1. Draw flow charts depicting the sequence of events that occur during reset, NMI, IRQ, and SWI.

2. Perform Lab Experiment 10 in the student workbook, Microprocessors.

SUGGESTED REFERENCE

Heath Company, Microprocessors, Book 2 and Student Workbook, Microprocessors, 19th printing. Heath Company, Benton Harbor, MI, 1983.

DEMONSTRATE RESET AND INTERRUPT SEQUENCES

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about subroutines.	Microprocessors, Book 2	
2	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessors, Book 2	
3	Have the student read about input-output operations.	Microprocessors, Book 2	
4	Have the student complete the "Self-Test Review" at the end of LA 3.	Microprocessors, Book 2	
5	Have the student read about interrupts.	Microprocessors, Book 2	
6	Have the student complete the "Self-Test Review at the end of LA 5.	Microprocessors, Book 2	
7	Have the student complete the Unit 6 Examination	Student workbook, Microprocessors	
8	Have the student perform the Check-Out Activities. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --Heathkit Lab Experiment 10 --Materials listed in Lab Experiment, or a substitute --Instructor's Final Checklist	

INTERFACE AND ACCESS MEMORY

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiments 11, 12, and 13, and the materials required:

1. Construct a memory circuit and interface it with the MPU.
2. Synchronize the MPU with an external timing signal.
3. Assemble and address decoding charts.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--Interfacing a microprocessor unit with memory is important in order to give it flexibility and make it useful.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
INTERFACE AND ACCESS MEMORY	7

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 11 in student workbook, Microprocessors.
2. Perform Lab Experiment 12 in Student Workbook, Microprocessors.
3. Perform Lab Experiment 13 in Student Workbook, Microprocessors.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 2 and student workbook, Microprocessors, 19th printing. Heath Company, Benton Harbon, MI 1983.

Graf, Modern Dictionary of Electronics, 5th Edition. Howard W. Sams and Co., Inc., Indianapolis, IN, 1982.

INTERFACE AND ACCESS MEMORY

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student define each of the words on the Vocabulary Sheet in writing.	Modern Dictionary of Electronics	
2	Have the student read about interfacing fundamentals.	Microprocessors, Book 2	
3	Have the student view a slide-tape presentation on interfacing.	Slide-tape, "Semiconductor Memories"	
4	Have the student complete the "Self-Test Review" at the end of LA 2.	Microprocessors, Book 2	
5	Have the student read about interfacing with random access memory.	Microprocessors, Book 2	
6	Have the student complete the "Self-Test Review" at the end of LA 4. You may want to have the student review some digital techniques before attempting the Check-Out Activities.	Microprocessors, Book 2	
7	Have the student perform the Check-Out Activities. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor Trainer --Heathkit Lab Experiments 11, 12 and 13. --Materials listed in the Lab Experiments or a substitute --Instructor's Final Checklist	

INTERFACE TO DISPLAY DEVICES

OBJECTIVE

Provided access to a Microprocessor trainer, Heathkit Lab Experiment 14, and the materials required, interface to external equipment, write programs, and demonstrate display decoding with both a decoder driver and the MPU.

You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED (AFFECTIVE DOMAIN):

--In order for a microprocessor to do more than manipulate data you must learn to interface it with external devices. The data can then take the form of a visual display or a digital control signal to manipulate an electro-mechanical device.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
INTERFACE TO DISPLAY DEVICES	5

CHECK-OUT ACTIVITY

Perform Lab Experiment 14 in Student Workbook, Microprocessors.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 2 and Student Workbook, Microprocessors, 19th Printing. Heath Company, Benton Harbor, MI, 1983.

Graf, Modern Dictionary of Electronics, 5th Edition. Howard W. Sams and Co., Inc., Indianapolis, IN, 1982.

INTERFACE TO DISPLAY DEVICES

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student define each of the words on the Vocabulary Sheet in writing.	Modern Dictionary of Electronics	
2	Have the student read about interfacing displays.	Microprocessors, Book 2	
3	Have the student complete the "Self-Test Review" at the end of LA 2.	Microprocessors, Book 2	
4	Have the student complete the Unit 7 examination.	Student Workbook, Microprocessors	
5	Have the student perform the Check-Out Activity. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor Trainer --Heathkit Lab Experiment 14 --Materials listed in the Lab Experiment or a substitute. --Instructor's Final Checklist	

INTERFACE A KEYBOARD TO A MICROPROCESSOR

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 15, and the materials required, interface a keyboard to a microprocessor. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED

In order to obtain the flexibility designed into a microprocessor, we must have a means for the input of data. It is of the utmost importance to have accurate, reliable input, in order to get useful, accurate output.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
INTERFACE A KEYBOARD TO A MICROPROCESSOR	3

CHECK-OUT ACTIVITY

Perform Lab Experiment 15 in student workbook, Microprocessors.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 2 and Student Workbook, Microprocessors, 19th printing. Heath Company, Benton Harbor, MI, 1983.

INTERFACE A KEYBOARD TO A MICROPROCESSOR

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about interfacing with switches.	Microprocessors, Book 2	
2	Have the student complete the "Self-Test Review at the end of LA 1. You may have an additional test you would like to give the student before the next learning activity.	Microprocessors, Book 2	
3	Have the student perform the Check-Out Activity. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --Heathkit Lab Experiment 15 --Materials listed in the Lab Experiment, or a substitute --Instructor's Final Checklist	

UTILIZE A PERIPHERAL INTERFACE ADAPTER TO INTERFACE STANDARD DEVICES

OBJECTIVE

Provided access to a microprocessor trainer, a peripheral interface adaptor, input and output devices, Heathkit Lab Experiments 16, 17 and 18, and the materials required, utilize a P.I.A. to interface standard devices. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED

The use of a P.I.A. can simplify interface requirements. In this task assignment sheet you will learn its versatility as an I/O Device.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
UTILIZE A PERIPHERAL INTERFACE ADAPTER TO INTERFACE STANDARD DEVICES	3-7

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 16 in student workbook, Microprocessors.

2. Perform Lab Experiments 17 and 18 in student workbook, Microprocessors.

SUGGESTED REFERENCES

Heath Company, Microprocessors, Book 2 and Student Wrokbook, Microprocessors, 19th printing. Heath Company, Benton Harbor, MI, 1983.

UTILIZE A PERIPHERAL INTERFACE ADAPTER TO INTERFACE STANDARD DEVICES

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read about PIAs.	Microprocessors, Book 2	
2	Have the student complete the "Self-test Review" at the end of LA 1.	Microprocessors Book 2	
3	Have the student perform Check-Out Activity 1. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer --PIA --Heathkit Lab Experiment 16 --Materials listed in the Lab Experiment or substitute --Instructor's Final Checklist	
4	Have the student view a slide-tape presentation on the use of a micro-porcessor in design and planning.	Slide-tape, "Designing With Microprocessors"	
5	Have the student read about using the PIA.	Microprocessors, Book 2	
6	Have the student complete the Unit 8 examination. You may have an additional test or exam to give the student.	Student Workbook, Microprocessors	
7	Have the student perform Check-Out Activity 2. Use the Instructor's Final Checklist to evaluate the student.	--Microprocessor trainer with PIA circuit --Heathkit Lab Experiments 17 and 18 --Materials listed in the Lab Experiments or a substitute --Instructor's Final Checklist	

USE ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION TECHNIQUES FOR SIGNAL CONVERSION

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 19, and the necessary electronic parts, construct a DAC, connect it to the microprocessor and write a functional program to convert digital values to their analog equivalent. Construct an ADC, connect it to the microprocessor and write a functional program to convert an analog signal to a digital value. You will be evaluated according to the Instructor's Final Checklist.

ATTITUDES AND VALUES TO BE DEVELOPED

--Converting between digital and analog is one of the most important processes used in interfacing for industrial applications. This allows hi tech applications of electronics to many industries.

CONTENTS

Instructor's Final Checklist	Learning Activity Number
USE ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION TECHNIQUES FOR SIGNAL CONVERSION	6

CHECK-OUT ACTIVITY

Perform Lab Experiment 19 in Student Workbook, Microprocessors.

SUGGESTED REFERENCES

Heath Company, Microporcessor Interfacing, Book 1, and Student Workbook, Microprocessor Interfacing, 2nd printing. Heath Company, Benton Harbor, MI, 1983.

USE ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION TECHNIQUES FOR SIGNAL CONVERSION

LA#	NOTES AND SUGGESTIONS FOR INSTRUCTION	REFERENCES AND SPECIAL TOOLS AND EQUIPMENT	TEACHER'S NOTES
1	Have the student read and study about DAC's.	Microprocessor Interfacing, Book 1	
2	Have the student complete the "Self-Test Review" at the end of LA 1.	Microprocessor Interfacing, Book 1	
3	Have the student read and study about ADC's.	Microprocessor Interfacing, Book 1	
4	Have the student complete the "Self-Test Review" at the end LA 3.	Microprocessor Interfacing, Book 1	
5	Have the student complete the Unit 1 Examination.	Microprocessing Interfacing - Student Workbook	
6	Have the student perform the Check-Out Activity.	--Microprocessor trainer --Oscilloscope --Volt-Ohm meter --Heathkit Lab Experiment 19 --Materials listed in the Lab Experiment or a substitute	
	Use the Instructor's Final Checklist to evaluate the student.	--Instructor's Final Checklist	

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ELECTRONICS TECHNICIAN

INSTRUCTOR'S PACKAGE/STUDENT PACKAGE

Task Assignment Sheets ET 1-15

Kentucky Department of Education
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Electronics Technician

CONVERT BETWEEN DECIMAL AND BINARY AND BETWEEN HEXADECIMAL AND DECIMAL NUMBERS

INTRODUCTION

A good foundation in numbers and codes is essential to understanding microprocessors. Binary numbers and codes are the basic language of all microprocessors. Hexadecimal numbers allow easy manipulation of binary numbers and data. In this task assignment sheet you will get a firm foundation in number systems and codes.

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiments 1 and 2, and the materials required:

1. Enter a program into the microprocessor trainer and convert between decimal and binary numbers.
2. Enter a program into the microprocessor trainer and convert between hexadecimal and decimal numbers.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 1 in Student Workbook, MICROPROCESSORS.
2. Perform Lab Experiment 2 in Student Workbook, MICROPROCESSORS.

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Alice McDonald, Superintendent of Public Instruction
1984-85

VOCABULARY

Define each of these words using your textbook and electronics dictionary as references.

Radix
Integer
Decimal
Binary
Octal
Hexadecimal
Bit
Parity
BCD
Gray Code
ASCII

Most Significant Bit (MSB)
Least Significant Bit (LSB)
Most Significant Digit (MSD)
Least Significant Digit (LSD)

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LEARNING ACTIVITIES

1. DEFINE each of the words on the Vocabulary Sheet of this Task Assignment Sheet.

2. READ and STUDY about number systems and codes.

   Reference: Microprocessors, Book 1, pp. 1-2 through 1-51.

3. COMPLETE each "Self-Test Review".

   Reference: Microprocessors, Book 1, pp. 1-7, 1-15, 1-25, 1-38 and 1-52 to 1-53.

4. COMPLETE Unit 1 Examination.

   Reference: Student Workbook, Microprocessors, pp. 299-300.

5. ARRANGE with your instructor to complete the Check-Out Activities.

Instructor's Final Checklist

CONVERT BETWEEN DECIMAL AND BINARY AND BETWEEN HEXADECIMAL AND DECIMAL NUMBERS

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

1. Performed Heathkit Lab Experiment 1

   a. Converted decimal numbers to their binary equivalent ..... [ ] [ ] [ ] [ ]
   b. Converted Binary numbers to their decimal equivalent ..... [ ] [ ] [ ] [ ]
   c. Entered, examined, and modified a simple program until 10 correct answers in succession were obtained .... [ ] [ ] [ ] [ ]

2. Performed Heathkit Lab Experiment 2

   a. Converted hexadecimal numbers to their decimal equivalent ..... [ ] [ ] [ ] [ ]
   b. Converted decimal numbers to their hexadecimal equivalent ..... [ ] [ ] [ ] [ ]

Electronics Technician

DRAW A BLOCK DIAGRAM OF A HYPOTHETICAL MICROPROCESSOR

INTRODUCTION

The thousands of transistors that make up a microprocessor are arranged to form many different circuits within the chip. The most important circuits on the chip are registers, counters, and decoders. In this task assignment sheet you will learn how these circuits can work together to perform simple but useful tasks.

OBJECTIVES

Provided access to reference materials:

1. Draw a block diagram of a hypothetical microprocessor.
2. Trace the data flow that takes place during the fetch and execute cycle of a simple program.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Draw a block diagram of a hypothetical microprocessor.
2. Trace the data flow that takes place during the fetch and execute cycle of a simple program.

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Alice McDonald, Superintendent of Public Instruction
1984-85

VOCABULARY

Define each of these words in writing, using your textbook and electronic dictionary for references.

Microprocessor
Microcomputer
Input
I/O
I/O device
I/O Port
Instruction
Program
Stored Program Concept
Word
Byte
MPU
ALU
Operand
Memory
Address
Read
Write
Ram
Fetch
Execute
MPU cycle
Mnemonic
Opcode
Bus

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LEARNING ACTIVITIES

1. DEFINE each of the words on the Vocabulary Sheet of this Task Assignment Sheet.

2. READ and STUDY about microprocessors.

   Reference: Microprocessors, Book 1, pp. 2-3 to 2-22.

3. VIEW a slide-tape presentation about microprocessors.

   Reference: Heathkit-Zenith, "Introduction to Microprocessors," Slides 1-8 to 1-49.

4. COMPLETE "Self-Test Reviews".

   Reference: Microprocessors, Book 1, pp. 2-10 and 2-23 to 2-24.

5. ARRANGE with your instructor to complete Check-Out Activity 1.

6. READ and STUDY about executing a program.

   Reference: Microprocessors, Book 1, pp. 2-26 to 2-65.

7. COMPLETE "Self-Test Reviews".

   Reference: Microprocessors, Book 1, pp. 2-39 and 2-66.

8. ARRANGE with your instructor to complete Check-Out Activity 2.

Instructor's Final Checklist

DRAW A BLOCK DIAGRAM OF A HYPOTHETICAL MICROPROCESSOR

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

1. While drawing a block diagram of a Microprocessor, the student:

a. Included all the circuits of the Microprocessor in the diagram	[ ]	[ ]	[ ]	[ ]
b. Drew the circuits in the sequence of operation	[ ]	[ ]	[ ]	[ ]

2. While tracing the data flow that takes place during the execution of a simple program, the student:

a. Traced the data through all fetch and execute phases	[ ]	[ ]	[ ]	[ ]
b. Gave a written description in step-by-step sequence of the data flow	[ ]	[ ]	[ ]	[ ]

Electronics Technician

WRITE A SIMPLE STRAIGHT LINE PROGRAM USING KEYBOARD FUNCTIONS

INTRODUCTION

In this task assignment sheet you will learn six basic microprocessor instructions that are represented by 8-Bit Binary numbers called Op-Codes.

Op-Codes allow the use of the microprocessor for data manipulation. There are also a number of trainer keyboard commands that you will learn in this task assignment sheet in order to examine and use the microprocessor instructions.

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 3, and the materials required, write a simple straight line program using keyboard functions. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 3 in Student Workbook, Microprocessors.

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Alice McDonald, Superintendent of Public Instruction
1984-85

VOCABULARY

Define these trainer keyboard commands in writing. They are found on pages 24 and 26 of the Student Workbook, Microprocessors.

DO	AUTO
EXAM	SS
FWD	ACCA
CHAN	PC
BACK	RESET

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LEARNING ACTIVITIES

1. DEFINE each of the words on the Vocabulary Sheet of this Task Assignment Sheet.

2. REVIEW the reading assignment about microprocessors and executing a program.

   Reference: Microprocessors, Book 1, pp. 2-3 to 2-65.

3. COMPLETE Unit 2 Examination, Microcomputer Basics.

   Reference: Student Workbook, Microprocessors pp. 301-304.

4. ARRANGE with your instructor to complete the CHECK-OUT ACTIVITY.

Instructor's Final Checklist

WRITE A SIMPLE STRAIGHT LINE PROGRAM USING KEYBOARD FUNCTIONS

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While writing a simple straight line program using keyboard functions, the student:

1. Ran an existing program and achieved the specified results ..... [ ] [ ] [ ] [ ]
2. Wrote a program using the direct addressing mode ..... [ ] [ ] [ ] [ ]
3. Ran the program written in 2. above and achieved the correct solution ..... [ ] [ ] [ ] [ ]
4. Ran an existing program to examine the three instructions introduced in the experiment ..... [ ] [ ] [ ] [ ]
5. Demonstrated a knowledge of the difference between RAM and ROM ..... [ ] [ ] [ ] [ ]

Electronics Technician

PERFORM ARITHMETIC AND LOGIC OPERATIONS ON BINARY NUMBERS

INTRODUCTION

It is important that you become familiar with binary numbers because microprocessors use them for data and control. Computer arithmetic involves many forms of number manipulation. In this task assignment sheet you will learn the fundamentals of binary mathematics: addition, subtraction, multiplication, and division. You will learn how the microprocessor performs the four basic boolean logic operations: AND, OR, exclusive OR, and INVERT.

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 4, and the materials required, perform arithmetic and logic operations on binary numbers. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 4 in Student Workbook, Microprocessors.

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Alice McDonald, Superintendent of Public Instruction
1984-85

VOCABULARY

Define each of these words or phrases using your textbook and electronics dictionary as references. These are new instructions used in lab experiment 4.

One's Complement

Two's Complement

AND Gate

OR Gate

Exclusive OR

Two's Complement Arithmetic

Invert

Logically Invert

Signed Numbers

Boolean Operation

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LEARNING ACTIVITIES

1. READ and STUDY about binary arithmetic.

   Reference: Microprocessors, Book 1, pp. 3-2 through 3-19.

2. DEFINE in writing each of the words on the Vocabulary Sheet in this Task Assignment Sheet.

3. COMPLETE the "Self-Test Review"

   Reference: Microprocessors, Book 1, pp. 3-20 and 3-21.

4. READ and STUDY about two's complement arithmetic.

   Reference: Microprocessors, Book 1, pp. 3-24 through 3-30.

5. COMPLETE the "Self-Test Review".

   Reference: Microprocessors, Book 1, p. 3-31.

6. READ and STUDY about Boolean operations.

   Reference: Microprocessors, Book 1, pp. 3-33 through 3-38.

7. COMPLETE the "Self-Test Review".

   Reference: Microprocessors, Book 1, pp. 3-39 and 3-40.

8. COMPLETE Unit 3 Examination.

   Reference: Student Workbook, Microprocessors, p. 305.

9. ARRANGE with your instructor to complete the Check-Out Activity.

Instructor's Final Checklist

PERFORM ARITHMETIC AND LOGIC OPERATIONS IN BINARY NUMBERS

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While performing arithmetic and logic operations in binary numbers, the student:

1.	Used the new instructions in simple programs	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
2.	Derived 2's complement of a binary number	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
3.	Performed binary subtraction	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4.	Performed binary addition of signed numbers .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5.	Performed logical manipulation of data using the AND and OR instructions	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Electronics Technician

DEVELOP FLOW CHARTING FOR PROGRAMMING

INTRODUCTION

The path that the computer takes through a program is called the flow of control, since control of the computer passes from statement to statement along this path. A flowchart is a diagram for illustrating the flow of control in a program.

Flowcharts constitute an algorithmic language, an informal language not accepted directly by a computer. Flowcharts are intended to be read by humans, not by computers. In this Task Assignment Sheet you will learn to construct flowcharts for use in programming.

OBJECTIVE

Provided an arithmetic operation to be performed, first construct a flowchart, then from the flowchart write a program that the computer can execute. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Obtain the necessary supplies and lab activity sheet from your instructor. Construct a flowchart, and write and execute a program to perform the desired arithmetic operation.

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Alice McDonald, Superintendent of Public Instruction
1984-85

LEARNING ACTIVITIES

1. READ about algorithms and developing flowcharts.

   Reference: Microprocessors, Book 1, pp. 4-27 to 4-41.

2. VIEW a slide-tape presentation about microprocessors and flowcharts.

   Reference: Heathkit/Zenith, "Interpretive Language," Slides 2-27 to 2-66.

3. PRACTICE tracing and constructing flowcharts for various programs.

   Reference: Microprocessors, Book 1, pp. 4-27 to 4-41 and Heathkit/Zenith, "Interpretive Language," Slides 2-27 to 2-66.

4. ARRANGE with your instructor to complete the Check-Out Activity.

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Instructor's Final Checklist

DEVELOP FLOW CHARTING FOR PROGRAMMING

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While developing flow charting for programming, the student:

1.	Constructed a flowchart using the correct symbols.....	[ ]	[ ]	[ ]	[ ]
2.	Constructed a flowchart showing the correct flow of control.....	[ ]	[ ]	[ ]	[ ]
3.	Converted the flowchart into a program.....	[ ]	[ ]	[ ]	[ ]
4.	Executed the program to perform the desired arithmetic operation.....	[ ]	[ ]	[ ]	[ ]

Electronics Technician

WRITE AND EXECUTE A PROGRAM CONTAINING BRANCH INSTRUCTIONS

INTRODUCTION

The programs you have studied so far were all "straight line" programs. The instructions were executed in numerical order. Such programs are extremely limited in the functions they can perform.

All microprocessors have the capacity to execute BRANCH instructions. These instructions allow the microprocessor to exit from the straight line sequence and execute a section of the program over and over again as often as needed. Branching increases the power of the microprocessor by greatly reducing the amount of time and number of memory locations required to store and execute a program. These reductions result in microprocessor applications which are lower in cost, more efficient, and require less space. You will learn to write programs containing BRANCH instructions in this Task Assignment Sheet.

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 5, and the materials required:

> Write and execute a program that will divide by repeated subtraction. The program must incorporate an unconditional branch and a conditional branch instruction.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 5, steps 20-22 in student workbook, Microprocessors.

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LEARNING ACTIVITIES

1. READ about unconditional branching.

   Reference: Microprocessors, Book 1, pp. 4-4 to 4-15.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, p. 4-16.

3. READ about conditional branching.

   Reference: Microprocessors, Book 1, pp. 4-18 to 4-24.

4. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, p. 4-25.

5. READ about algorithms.

   Reference: Microprocessors, Book 1, pp. 4-27 to 4-41.

6. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, p. 4-42.

7. Perform Lab Experiment 5, steps 1-19.

   Reference: Student Workbook, Microprocessors, pp. 53-70.

8. ARRANGE with your instructor to complete Check-Out Activity 1.

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Instructor's Final Checklist

WRITE AND EXECUTE A PROGRAM CONTAINING BRANCH INSTRUCTIONS

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While writing and executing a program containing branch instructions, the student:

1.	Followed the given flowchart as a guide for dividing by repeated subtraction	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
2.	Incorporated an unconditional branch instruction	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
3.	Incorporated a conditional branch instruction	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
4.	Calculated the correct relative addresses	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
5.	Constructed a functional program	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	

Electronics Technician

WRITE AND EXECUTE PROGRAMS ILLUSTRATING MUTIPLE-PRECISION ARITHMETIC OPERATIONS

INTRODUCTION

The largest unsigned number that can be represented by a single byte is 255_{10}. Therefore, larger numbers must be represented by stringing together two or more bytes. This is known as multiple-precision arithmetic. The MPU can work with numbers of virtually any size by using this method. You will learn to write and execute programs requiring the use of multiple-precision arithmetic in this task assignment sheet.

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 6, and the materials required:

1. Write and execute a program that will perform multiple-precision subtraction.
2. Write and execute programs that use the ASLA and DAA instructions.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 6, Steps 11-13.
2. Perform Lab Experiment 6, Steps 14-26.

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LEARNING ACTIVITIES

1. READ about multiple-precision arithmetic.

   Reference: Microprocessors, Book 1, pp. 4-44 - 4-53.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, p. 4-54.

3. PERFORM Lab Experiment 6, Steps 1-10.

   Reference: Student Workbook, Microprocessors, pp. 89-95.

4. ARRANGE with your instructor to complete the Check-Out Activities.

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Instructor's Final Checklist

WRITE AND EXECUTE PROGRAMS ILLUSTRATING MULTIPLE-PRECISION ARITHMETIC OPERATIONS

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While writing and executing programs illustrating multiple-precision arithmetic operations, the student:

1. Performed Lab Experiment 6, Steps 11-13:
   a. Followed the given guidelines ..... [ ] [ ] [ ] [ ]
   b. Wrote a functional multiple-precision subtraction program ..... [ ] [ ] [ ] [ ]
2. Performed Lab Experiment 6, Steps 14-26:
   a. Wrote a functional program using the ASLA instruction to multiply by 16_{10} .... [ ] [ ] [ ] [ ]
   b. Entered and executed the BCD packing program ..... [ ] [ ] [ ] [ ]
   c. Entered and executed programs illustrating the purpose of the DAA instruction ..... [ ] [ ] [ ] [ ]

Electronics Technician

WRITE AND EXECUTE PROGRAMS USING EXTENDED AND INDEXED ADDRESSING

INTRODUCTION

The highest address an eight-bit byte can specify is FF_{16} in the direct addressing mode. This limits the useable RAM size to 256_{10} bytes. This represents less than one percent of the addresses available to the 6800 MPU.

Through the use of extended and indexed addressing the size of the RAM can be increased to $65,536_{10}$ possible address locations. You will learn to write and execute programs utilizing extended and indexed addressing in this task assignment sheet.

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 7, and the materials required, write and execute programs that utilize extended and indexed addressing. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 7, steps 17 through 25.

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LEARNING ACTIVITIES

1. READ about the architecture of the 6800 MPU.

   Reference: Microprocessors, Book 1, pp. 5-2 to 5-10.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, p. 5-11.

3. READ about the instruction set of the 6800 MPU.

   Reference: Microprocessors, Book 1, pp. 5-13 to 5-29.

4. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, pp. 5-30 and 5-31.

5. READ about extended and indexed addressing.

   Reference: Microprocessors, Book 1, pp. 5-34 to 5-46.

6. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 1, pp. 5-47 and 5-48.

7. PERFORM Lab Experiment 7, Steps 1-16.

   Reference: Student Workbook, Microprocessors, pp. 111-117.

8. COMPLETE Unit 5 Examination.

   Reference: Student Workbook, Microprocessors, pp. 309-315.

9. ARRANGE with your instructor to complete the Check-Out Activity.

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Instructor's Final Checklist

WRITE AND EXECUTE PROGRAMS USING EXTENDED AND INDEXED ADDRESSING

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While writing and executing programs using extended and indexed addressing, the student:

1. Wrote a functional program using indexed addressing to clear specified memory locations ..... [ ] [ ] [ ] [ ]

2. Wrote a functional program to illustrate the offset capability of indexed addressing ..... [ ] [ ] [ ] [ ]

LEARNING ACTIVITIES

1. READ and STUDY about stack operations.

   Reference: Microprocessors, Book 2 pp. 6-4 to 6-13.

2. COMPLETE "Self-Test Review".

   Reference: Microprocessors Book 2, page 6-13.

3. ARRANGE with your instructor to complete the Check-Out Activity.

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Instructor's Final Checklist

LOAD AND EXECUTE A MEMORY BLOCK MOVE PROGRAM

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While loading and executing a memory block move program, the student:

1. Used a simple program that could store data in and retrieve data from the stack ..... [ ] [ ] [ ] [ ]
2. Demonstrated the stack operations that occur automatically ..... [ ] [ ] [ ] [ ]
3. Demonstrate ways the programmer can use the stack ..... [ ] [ ] [ ] [ ]
4. Executed a program that used the stack and indexing to move a list from one place in memory to another ..... [ ] [ ] [ ] [ ]

Electronics Technician

DEMONSTRATE RESET AND INTERRUPT SEQUENCES

INTRODUCTION

While input-output (I/O) operations use part of the interrupt capability of the MPU, interrupts are also used in other ways. The 6800 MPU has four different types of interrupts, they are: reset, non-maskable interrupt (NMI), interrupt request (IRQ), and software interrupt (SWI). This task assignment sheet will examine each of these interrupts in detail.

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiment 10 and the materials required:

1. Draw flow charts depicting the sequence of events that occur during reset, NMI, IRQ, and SWI.

2. Demonstrate the use of subroutines.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Draw flow charts depicting the sequence of events that occur during reset, NMI, IRQ, and SWI.

2. Perform Lab Experiment 10 in the student workbook, Microprocessors.

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LEARNING ACTIVITIES

1. READ and STUDY about subroutines.

   Reference: Microprocessor, Book 2, pp. 6-15 to 6-22.

2. COMPLETE the "Self-Test Review".

   Reference: Microprocessor, Book 2, p. 6-23.

3. READ and STUDY about input-output operations.

   Reference: Microprocessor, Book 2, pp. 6-25 to 6-32.

4. COMPLETE the "Self-Test Review".

   Reference: Microprocessor, Book 2, p. 6-33.

5. READ and STUDY about interrupts.

   Reference: Microprocessor, Book 2, pp. 6-35 to 6-45.

6. COMPLETE the "Self-Test Review".

   Reference: Microprocessor, Book 2, p. 6.46.

7. COMPLETE Unit 6 Examination.

   Reference: Student Workbook, Microprocessors, pp. 317-318.

8. ARRANGE with your instructor to complete the Check-Out Activities.

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Instructor's Final Checklist

DEMONSTRATE RESET AND INTERRUPT SEQUENCES

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While demonstrating reset and interrupt sequences, the student:

1. Drew flow charts depicting the sequence of events that occur during:

a. Reset.....	[ ]	[ ]	[ ]	[ ]
b. NMI.....	[ ]	[ ]	[ ]	[ ]
c. IRQ.....	[ ]	[ ]	[ ]	[ ]
d. SWI.....	[ ]	[ ]	[ ]	[ ]

2. Performed Lab Experiment 10:

a. Demonstrated subroutines	[ ]	[ ]	[ ]	[ ]
b. Wrote a program that displayed seconds ..	[ ]	[ ]	[ ]	[ ]
c. Wrote a program that displayed minutes and seconds	[ ]	[ ]	[ ]	[ ]
d. Wrote a program that displayed hours, minutes, and seconds	[ ]	[ ]	[ ]	[ ]

Electronics Technician

INTERFACE AND ACCESS MEMORY

INTRODUCTION

There are two things that can be done with a microprocessor. They can be programmed and interfaced. In this task assignment sheet you will learn to interface the microprocessor to memory, where your program will be stored, and to use the stored program. You will also investigate timing, which assures that the microprocessor knows what to do next.

OBJECTIVES

Provided access to a microprocessor trainer, Heathkit Lab Experiments 11, 12, and 13, and the materials required:

1. Construct a memory circuit and interface it with the MPU.
2. Synchronize the MPU with an external timing signal.
3. Assemble and address decoding charts.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 11 in student workbook, Microprocessors.
2. Perform Lab Experiment 12 in Student Workbook, Microprocessors.
3. Perform Lab Experiment 13 in Student Workbook, Microprocessors.

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VOCABULARY

Define each of these words in writing using your textbook and electronics dictionary as references.

Memory Map
Address Decoding
Address Decoding Chart
Synchronize
Interrupt Request
Full Address Decoding
Partial Address Decoding
Logic Circuit
Combinational Logic Circuit
Program Loop
Clock
Data Table
Timing Diagram
256 X 4 Ram

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LEARNING ACTIVITIES

1. DEFINE each of the words on the Vocabulary Sheet of this task assignment sheet in writing.

   Reference: Modern Dictionary of Electronics.

2. READ about interfacing fundamentals.

   Reference: Microprocessors, Book 2, pp. 7-2 to 7-15.

3. VIEW a slide-tape presentation on interfacing.

   Reference: Heathkit/Zenith, "Semiconductor Membories," Slides 3-1 to 3-44.

4. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 2, p. 7-16.

5. READ about interfacing with random access memory.

   Reference: Microprocessors, Book 2, pp. 7-18 to 7-31.

6. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 2, p. 32.

7. ARRANGE with your instructor to complete the Check-Out Activities.

Instructor's Final Checklist

INTERFACE AND ACCESS MEMORY

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While interfacing and accessing memory, the student:

1. Constructed a memory circuit and interfaced it with the MPU:

a. Loaded data into memory	[ ]	[ ]	[ ]	[ ]
b. Retrieved previously stored data	[ ]	[ ]	[ ]	[ ]
c. Determined the validity of memory	[ ]	[ ]	[ ]	[ ]

2. Synchronized the MPU with an external signal:

a. Entered program	[ ]	[ ]	[ ]	[ ]
b. Entered clock start data	[ ]	[ ]	[ ]	[ ]
c. Displayed correct time	[ ]	[ ]	[ ]	[ ]
d. Displayed seconds digit updating at a one-second rate	[ ]	[ ]	[ ]	[ ]

3. Assembled an address decoding chart:

a. Entered program for memory decoding	[ ]	[ ]	[ ]	[ ]
b. Constructed a decoding chart	[ ]	[ ]	[ ]	[ ]
c. Changed decoding addresses	[ ]	[ ]	[ ]	[ ]
d. Examined locations and determined address code accuracy	[ ]	[ ]	[ ]	[ ]

Electronics Technician

INTERFACE TO DISPLAY DEVICES

INTRODUCTION

Using the skills developed in previous task assignment sheets you will interface the Microprocessor Unit to external display devices. You will use a 7-segment LED display because of its low cost and flexibility.

OBJECTIVE

Provided access to a Microprocessor trainer, Heathkit Lab Experiment 14, and the materials required, interface to external equipment, write programs, and demonstrate display decoding with both a decoder driver and the MPU.

You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 14 in Student Workbook, Microprocessors.

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VOCABULARY

Define each of these words in writing using your text book and electronics dictionary as references.

7 Segment Display
Common Anode
Common Cathode
LED
Delay Loop
Array
Decoder Driver
Segment
Display
Float
Cyclic
Sub routine

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LEARNING ACTIVITIES

1. DEFINE each of the words on the Vocabulary Sheet of this Task Assignment Sheet in writing.

   Reference: Modern Dictionary of Electronics.

2. READ about interfacing with displays.

   Reference: Microprocessors, Book 2, pp. 7-34 to 7-46.

3. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 2, p. 7-47.

4. COMPLETE Unit 7, Examination.

   Reference: Student Workbook, Microprocessors, pp. 319-320.

5. ARRANGE with your instructor to complete the Check-Out Activity.

Instructor's Final Checklist

NTERFACE TO DISPLAY DEVICES

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

1	2	3	4
Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level

While interfacing to display devices, the student:

1.	Interfaced to external equipment	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
2.	Wrote and executed a program that alternately turned all the data LED's on and off	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
3.	Wrote and executed a program that alternately stored 1's and 0's to the display LED's	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4.	Wrote and executed a program that caused the 7-segment display to count from 0 to F and then continuously repeat	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5.	Used both common cathode and common-anode type displays	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
6.	Executed programs both with and without a decoder driver	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Electronics Technician

INTERFACE A KEYBOARD TO A MICROPROCESSOR

INTRODUCTION

Many types of input devices can be connected to a microprocessor but the simplest of all is the mechanical switch. Depending upon the program in operation, the switch can represent many different types of information.

The basic simplicity of the switch ensures a high degree of reliability, but also brings the problem of "contact bounce." This task assignment sheet will allow you to investigate this property and examine the process by which it is accommodated.

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 15, and the materials required, interface a keyboard to a microprocessor. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 15 in student workbook, Microprocessors.

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LEARNING ACTIVITIES

1. READ and STUDY about interfacing with switches.

   Reference: Microprocessors, Book 2, pp. 8-4 to 8-15.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 2, p. 8-16, questions 1-11.

3. ARRANGE with your instructor to complete the CHECK-OUT ACTIVITY.

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INSTRUCTOR'S FINAL CHECKLIST

NTERFACE A KEYBOARD TO A MICROPROCESSOR

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

1	2	3	4
Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level

While interfacing a keyboard to the microprocessor, the student:

1. Breadboarded mechanical switches and correctly connected them to the microprocessor ..... [ ] [ ] [ ] [ ]

2. Wrote a program that provided external data input into the microprocessor ..... [ ] [ ] [ ] [ ]

3. Wrote a program that eliminated the effects of contact bounce ..... [ ] [ ] [ ] [ ]

Electronics Technician

UTILIZE A PERIPHERAL INTERFACE ADAPTER TO INTERFACE STANDARD DEVICES

INTRODUCTION

Any peripheral can be interfaced to a microprocessor by using standard integrated circuits. Considering the diversity of possible peripherals, it is a definite plus to have general purpose, large scale, integrated circuits that can be configured to most situations. Both hardware and software configuration techniques are used. This section allows you to investigate the characteristics of a Peripheral Interface Adapter (P.I.A.) and to modify those same characteristics through programming.

OBJECTIVE

Provided access to a microprocessor trainer, a peripheral interface adaptor, input and output devices, Heathkit Lab Experiments 16, 17 and 18, and the materials required, utilize a P.I.A. to interface standard devices. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITIES

1. Perform Lab Experiment 16 in student workbook, Microprocessors.
2. Perform Lab Experiments 17 and 18 in student workbook, Microprocessors.

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LEARNING ACTIVITIES

1. READ and STUDY about the peripheral interface adapter.

   Reference: Microprocessors, Book 2, pp. 8-18 to 8-28.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessors, Book 2, p. 8-29, questions 12-20.

3. ARRANGE with your instructor to complete CHECK-OUT ACTIVITY 1.

4. VIEW a slide-tape presentation on the use of a microprocessor in design and planning.

   Reference: Heathkit/Zenith, "Designing With Microprocessors," Slides 4-1 to 4-44.

5. READ and STUDY about using the P.I.A.

   Reference: Microprocessors, Book 2, pp. 8-31 to 8-37.

6. COMPLETE Unit 8 Examination.

   Reference: Student Workbook, Microprocessors, p. 321.

7. ARRANGE with your instructor to complete CHECK-OUT ACTIVITY 2.

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INSTRUCTOR'S FINAL CHECKLIST

UTILIZE A PERIPHERAL INTERFACE ADAPTER TO INTERFACE STANDARD DEVICES

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While utilizing a P.I.A. to interface standard devices, the student:

1. Performed Healthkit Lab Experiemnt 16.

   a. Breadboarded P.I.A. to microprocessor .. [ ] [ ] [ ] [ ]

   b. Programmed the P.I.A. for correct input-output pin configuration ..... [ ] [ ] [ ] [ ]

2. Performed Heathkit Lab Experiments 17 and 18.

   a. Wrote an output program that supplied data to drive a speaker ..... [ ] [ ] [ ] [ ]

   b. Wrote a program that encoded a keyboard ..... [ ] [ ] [ ] [ ]

Electronics Technician

USE ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION TECHNIQUES FOR SIGNAL CONVERSION

INTRODUCTION

For any digital circuit to control an analog system, interfacing must first be accomplished. The particular form of interfacing demonstrated in this section is termed digital to analog conversion (DAC). Each digital pattern must be converted to its equivalent value of analog voltage. In a typical installation, an eight bit processor might control a zero to ten volt circuit. The maximum value the processor could output is 255 or FF in base 16. Using ten volts on the convertor, each processor step would equal 39.2 millivolts (10/255). As an example, the processor might output B7. The convertor would then translate the binary pattern for B7 into an analog voltage of 7.174 volts (B7=183, 183 x .0392=7.174).

There are many examples of this interfacing technique in industrial situations; office copiers, motor controls, robots, and process control are a few. A high technology example is the space shuttle in which a computer supervises the movement of the flight control surfaces. All of these applications of the computer would be impossible or prohibitively costly without a simple digital to analog convertor.

OBJECTIVE

Provided access to a microprocessor trainer, Heathkit Lab Experiment 19, and the necessary electronic parts, construct a DAC, connect it to the microprocessor and write a functional program to convert digital values to their analog equivalent. Construct an ADC, connect it to the microprocessor and write a functional program to convert an analog signal to a digital value. You will be evaluated according to the Instructor's Final Checklist.

CHECK-OUT ACTIVITY

Perform Lab Experiment 19 in Student Workbook, Microprocessors.

Kentucky Department of Education
Alice McDonald, Superintendent of Public Instruction
1984-85

LEARNING ACTIVITIES

1. READ AND STUDY about DAC's.

   Reference: Microprocessor Interfacing, Book 1, pp. 1-36 to 1-53.

2. COMPLETE the "Self-Test Review."

   Reference: Microprocessor Interfacing, Book 1, pp. 1-54 and 1-55, questions 26-39.

3. READ AND STUDY about ADC's.

   Reference: Microprocessor Interfacing, Book 1, pp. 1-58 to 1-67.

4. COMPLETE the "Self-Test Review."

   Reference: Microprocessor Interfacing, Book 1, pp. 1-68 and 1-69, questions 40-50.

5. COMPLETE Unit 1 Examination.

   Reference: Microprocessor Interfacing, Student Workbook, pp. 111-113, questions 1-15.

6. ARRANGE with your instructor to complete the Check-Out Activity.

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INSTRUCTOR'S FINAL CHECKLIST

USE ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION TECHNIQUES FOR SIGNAL CONVERSION

The student should be evaluated according to the performance ratings in the box. Indicate on a separate sheet of paper the student's performance for each item.

Performance Level: All items must receive a rating of "2," or better. If any items are rated less than "2," the student and instructor will decide what Learning Activities must be repeated.

Task Performance Unacceptable	Task Performance at Acceptable Level	Task Performance Without Assistance	Task Performance at Technician Level
1	2	3	4

While using analog to digital and digital to analog conversion techniques for signal conversion, the student:

1. Constructed and connected a DAC to a microprocessor ..... [ ] [ ] [ ] [ ]
2. Wrote a functional program that converted digital values to their analog equivalent ..... [ ] [ ] [ ] [ ]
3. Constructed and connected an ADC to a microprocessor ..... [ ] [ ] [ ] [ ]
4. Wrote a functional program that converted an analog signal to a digital value ..... [ ] [ ] [ ] [ ]